SOLVAY MINERALS

Copy Sent To: Tony Hoyt
Date 5/1/03

MAY 2003
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DIVISION

April 30, 2003

Cortnie Morrell
WDEQ-Air Quality Division
122 W. 25th Street
Cheyenne, WY 82002

RE: Reply to WDEQ April 4, 2003 letter regarding AP-0631

Dear Cortnie:

Attached is an addendum to the March 6, 2003 submittal of Solvay Minerals' gas-to-coal permit application AP-0631 per your April 4, 2003 letter.

VOC and CO BACT:
The VOC and CO BACT analyses referenced in permit application AP-0631 have been updated and are included as Appendix A of this submittal. The RACT, BACT, LAER Clearinghouse (RBLC) was reviewed for CO and VOC control technologies. It was determined that the only technically feasible CO control is good combustion practices. The cost-effectiveness for regenerative thermal oxidation (RTO) and regenerative catalytic oxidation (RCO) were both determined to be economically unreasonable at over $7,000 per ton VOC controlled. BACT for both CO and VOC for the trona calciner system is good combustion practices.

Particulate BACT:
The particulate BACT analysis has been amended and is attached as Appendix B. It includes cost estimates for modification to the existing ESP to control particulate emissions to a rate of 0.015 gr/dscf. This is the most stringent particulate emission rate that has been permitted and demonstrated in an existing trona calciner system. That calciner is at the Solvay facility and is designated as AQD #80. This source was permitted under CT-1347 issued February 6, 1998. The cost to retrofit the existing ESP to increase the control efficiency from 0.02 gr/dscf to 0.015 gr/dscf is over $12,000 per ton particulate controlled. This is economically unreasonable. BACT for particulate for this trona calciner system is an ESP at 0.02 gr/dscf.

NO_X BACT:
Further details of the NO_X BACT are attached as Appendix C. The technical and economic feasibility of flue gas recirculation and water injection are addressed, and an update to the RBLC information submitted in the original application is included. The cost effectiveness of flue gas recirculation is $839 per ton NO_X controlled, and of water

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injection is $1,494 per ton NO_X controlled. These are reasonable control costs. These control technologies lower the combustion temperature in the calciner furnace, controlling the formation of thermal NO_X. Further details of these control measures is found in the document entitled "NO_X Control Procedures - Calciner CA-1 and CA-2 Coal-Stoker Furnaces" in Appendix C.

If you have any questions concerning this submittal, please feel free to contact me at (307) 872-6571.

Respectfully submitted,
SOLVAY MINERALS, INC.

Dolly A. Potter

Dolly A. Potter
Environmental Services Supervisor

cc: Tony Hoyt w/o attahcments

SUPPLEMENT TO CO & VOC BACT ANALYSIS
TECHNICAL SUPPORT FOR PERMIT MODIFICATION APPLICATION
SOLVAY MINERALS - CALCINERS A & B FUEL SWITCH

This supplement provides an updated review of the RACT, BACT, LAER Clearinghouse (RBLC) for CO and VOC control technology determinations. In order to determine what CO and VOC control technologies are feasible for the Solvay furnace, the RBLC was searched as of March 2003. Tables 1 and 2 summarize the CO and VOC BACT determinations for all combustion sources (and all fuels) except boilers, steel furnaces, foundries, and casting operations. Boilers are eliminated because they are fundamentally a different type of facility with lower temperatures and heat extraction within the combustion chamber. Steel furnaces, foundries, and casting operations are eliminated because the emissions are collected by the hoods above the molten metal pots or containers. These emissions are from the impurities in the metals (including scrap), with no combustion air treated. In these exhaust airflows the VOC concentration is relatively high, and the exhaust is much more economical to clean than when diluted with combustion air. The RBLC search covered the 10-year period from January 1993 through March 2003.

Table 1: RBLC CO Control Determinations for all Combustion Sources Except Boilers, Steel Furnaces, Foundries, and Casting Operations

Listed CO Control Technology	Number of Determinations
Good combustion practices	21
Process design	6
Thermal or catalytic oxidation	7
None listed	16
Total	50

All of the Table 1 facilities with thermal or catalytic oxidation are also listed in Table 2 as BACT for VOCs. Thus, all of these Table 1 listings of oxidation add-on controls are actually VOC BACT determinations with the coincidental benefit of CO control. None of the BACT determinations of thermal or catalytic oxidation are actually for CO, and therefore are considered "technically infeasible" for CO control. Solvay concludes that "good combustion practices" is considered BACT for CO.

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Table 2: RBLC VOC Control Determinations for all Combustion Sources Except Boilers, Steel Furnaces, Foundries, and Casting Operations

Listed VOC Control Technology	Number of Determinations
Good combustion practices	5
Process design	3
Thermal or catalytic oxidation	11
Adsorption	2
None listed	29
Total	50

The RBLC analysis shows that 37 of the 50 (74 percent) technologies consider good combustion practices, a well-designed process, or nothing as BACT for VOC control. These are not add-on control technologies. The Table 2 summary indicates that add-on controls have been installed on some sources with VOC emissions and can be considered technologically feasible. Both regenerative thermal oxidation (RTO) and regenerative catalytic oxidation (RCO) have potential for control efficiencies over 95 percent. The adsorption process is eliminated in favor of RTO or RCO because of the high volume of gas to be treated. The adsorption process cost will be well above the RTO or RCO cost on a per-ton of VOC controlled basis. Details of the RBLC search are attached.

The cost analyses for the retrofit of both an RTO (with 95-percent heat recovery) and an RCO (with 70-percent heat recovery) system are attached. An analysis was also performed for lower heat recovery systems, and the costs are higher than for the attached cases. The attached cost analyses are based on the emissions from Source 17 producing at its capacity throughput rate of 320 tph. The measured VOC emissions of 0.8 lb/ton of throughput (see CT-1347 permit application submitted June 4, 1997 and issued February 6, 1998), or 1,121 tpy are available for control. This analysis shows a similar cost for both RTO and RCO, which is over $7,000 per ton of VOC controlled. Solvay believes that $7,000 is well above a reasonable cost for installation of either of these VOC control technologies. Therefore, BACT for VOC emissions from Solvay's modified Source 17 is considered to be "good combustion practices."

RBLCID	FACILITY	PROCESS	FUEL	THRUPUT	THRUPUTUNIT	POLLUTANT	CONTROLCOD	CTRLDESC	EMISLIMIT1	EMISLIMIT1UNIT	BASIS	PCTEFFIC
AL-0097	MEAD COATED BOARD, INC.	FURNACE RECOVERY		2.7	MMLB/D BLS	VOC	P	BOILER DESIGN AND COMBUSTION CONTROL	0.048	LB/MMBTU	BACT-PSD	0
AL-0116	GULF STATES PAPER CORPORATION	FURNACE, RECOVERY		3.94	MMLB/D BLS	VOC	P	PROPER DESIGN AND OPERATION	0.03	LB/MMBTU	BACT-PSD	0
AL-0121	ELF ATOCHEM NORTH AMERICA, INC	D-200 LATEX POLYMERS DRYER A		46800000	LB/YR	VOC	N		52.3	LB/H	BACT-PSD	0
AL-0121	ELF ATOCHEM NORTH AMERICA, INC	D-200 LATEX POLYMERS DRYER B		56800000	LB/YR	VOC	N		61.6	LB/H	BACT-PSD	0
AL-0122	GULF STATES PAPER CORP	KILNS, LUMBER DRY		0		VOC	N		5.48	LB/MBF	BACT-PSD	0
AL-0163	GULF LUMBER COMPANY - MOBILE	DRY KILNS	NATURAL GAS	68.88	MBF/YR	VOC	P	GOOD ENGINEERING PRACTICES	4.52	LB/MBF	BACT-PSD	
AL-0163	GULF LUMBER COMPANY - MOBILE	LUMBER DRY KILN	STEAM	126	MBF/YR	VOC	P	GOOD ENGINEERING PRACTICES	4.52	LB/MBF	BACT-PSD	
AL-0177	MOUNDVILLE SAWMILL	HIGH TEMP STEAM HEATED DRY KILN	WOOD WASTE/NAT. GAS	143	MBF	VOC	N		5.48	LB/MBF	BACT-PSD	
AR-0023	GEORGIA-PACIFIC ORIENTED STRANDBOARD FACILITY	DRYER, 5, EACH	WOOD WASTES,20%FI NES	475	MMSF/Y	VOC	B	RTO WITH MULTICLONES, GOOD COMBUSTION	25.25	LB/H	BACT-PSD	90
AR-0029	TEMPLE INLAND FOREST PRODUCTS CORP.	DRYER, PROCESS, 3	WOOD DUST	58	MMBTU/H	VOC	N		88.8	LB/H	BACT-PSD	0
AR-0029	TEMPLE INLAND FOREST PRODUCTS CORP.	PRE DRYER	WOOD DUST	39	MMBTU/H	VOC	A	REATIVE THERMAL OXIDIZER	7.9	LB/H	BACT-PSD	95
AR-0032	FREEMAN BROTHERS, INC., BIBLER BROTHERS LUMBER CO.	LUMBER MILL, DRYING KILN		70	MMBF/YR	VOC	P	CLEAN FUEL	3.5	LB/MBF	OTHER	
AR-0034	ARKANSAS LIME COMPANY	LIME MANUFACTURING - ROTARY LIME KILN, NO. 2	NATURAL GAS	600	T/D	VOC	N		14.2	T/YR	OTHER	
AR-0036	FREEMAN BROTHERS / BIBLER BROTHERS LUMBER COMPANY	DRYING KILNS	NATURAL GAS	70	MMBTU/H	VOC	N		61.3	LB/H VOCS	BACT-PSD	
AR-0038	POTLATCH CORPORATION - SOUTHERN AND BRADLEY UNITS	DRYING KILNS		241200	MBF	VOC	A	NONE ADDED	150.7	LB/H	BACT-PSD	
AR-0046	POTLATCH - OZAN UNIT	LUMBER DRY KILN		230	MMBF/YR	VOC	N		3.5	LB/MBF	BACT-PSD	
CA-0923	ARAMARK UNIFORM CLEANERS	DRYER, NATURAL GAS	NATURAL GAS	2.75	MMBTU/H	VOC	N		0.0055	LB/MMBTU	BACT-PSD	
CO-0047	HOLNAM, FLORENCE	KILN/PREHEATER/BYPASS & CLINKER COOLER EXHAUST	COAL			VOC	P	GOOD COMBUSTION	180.5	T/YR	BACT-PSD	
CO-0048	HOLNAM, LAPORTE CO.	CALCINER/ KILN	COAL	584000	T/YR	VOC	P	KILN DESIGNED TO REMOVE KEROGENS FROM RAW MATERIAL. VOC DOES NOT TRIGGER PSD.	40	LB/H	OTHER	
FL-0211	GEORGIA PACIFIC - HOSFORD OSB PLANT	FLAKE DRYERS, 5	WOOD	550216	T	VOC	A	REGENERATIVE THERMAL OXIDIZERS	63.1	LB/H	BACT-PSD	90

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FL-0217	CHAMPION INTERNATIONAL CORPORATION	STEAM DRYING KILNS (3)		225 MMBF/YR	VOC	P	USE OF NATURAL GAS. OTHER CONTROL OF VOC NOT ECONOMICALLY FEASIBLE. ESTIMATED EMISSIONS 320 T/YR. NO EMISSION RATE LIMIT SET.		BACT-PSD	
LA-0116	WILLAMETTE INDUSTRIES, INC.	LUMBER DRY KILNS (2 UNITS)		40 MMBF/YR	VOC	N	NO CONTROL IS BACT	33.33 LB/H	BACT-PSD	
LA-0122	INTERNATIONAL PAPER - MANSFIELD MILL	LIME KILN		142 MMBTU/H	VOC	A	VENTURI SCRUBBER USING FRESH WATER	8.3 LB/H	BACT-PSD	
LA-0122	INTERNATIONAL PAPER - MANSFIELD MILL	LIME KILN AUXILIARY ENGINE		370 HP	VOC	P	PREVENTATIVE MAINTENANCE	5.4 LB/H	BACT-PSD	
LA-0122	INTERNATIONAL PAPER - MANSFIELD MILL	LIME KILN GASOLINE TANK		560 GAL	VOC	P	SUBMERGED FILL PIPE	0.04 LB/H	BACT-PSD	
MI-0287	HOLNAM, INC.	CEMENT KILNS, WET PROCESS (2)	COAL	100 T/H FEED	VOC	A	REGENERATIVE THERMAL OXIDIZERS, THREE IN PARALLEL PER KILN. STANDBY ACTIVATED CARBON FOR BACKUP. CURRENT EXISTING LIMITS DO NOT REFLECT ADDITIONAL 80% REMOVAL ANTICIPATED IN RTOS.	13 LB/T	BACT-OTHI	80
MI-0297	MINERGY DETROIT LLC	SLUDGE INCINERATOR/GLASS FURNACE	WWTP SOLIDS, COAL, SUPPLEMENTAL GAS (AS NEEDED)	27.6 T/H @ 10% H2O	VOC	A	CARBON INJECTION/BAGHOUSE. COMPLIANCE WILL BE BY TESTING.	7.24 PPMDV @ 12% O2	BACT-PSD	
MI-0353	WEYERHAEUSER	DRYERS AND BURNERS, WOOD CHIP	WOOD	108000 LB/H	VOC	A	RTO	18.6 LB/H	BACT-PSD	
MI-0354	HOLNAM, INC	CEMENT KILNS, WET PROCESS, (2)	COAL	100 T/H	VOC	A	COOLING AIR CONDENSER REMOVES PAH AND ORGANICS BEFORE BAGHOUSE. ACTIVATED CARBON IS INJECTED FOR ADSORPTION OF POLLUTANTS. REMOVAL IN BAGHOUSE. CARBON SYSTEM PER PERMIT 60-71H.	7217 T/YR	BACT-OTHI	

MN-0042	POTLATCH CORPORATION	WOOD WAFER DRYER, TRIPLE PASS ROTARY DRUM	WOOD	33000 LB/H	VOC	A	RTO (REGENERATIVE THERMAL OXIDIZER)	8 LB/H	BACT-PSD	
MS-0029	WEYERHAEUSER COMPANY	RECOVERY FURNACE AND BOILER		7 MMLBS/DAY	VOC	P	EFFICIENT OPERATION	0.6 LB/T BLS	BACT-PSD	0
MS-0048	INTERNATIONAL PAPER COMPANY MORTON LUMBER MILL	DRY KILN NO. 4	WOOD	30000 MBF/YR	VOC	N		5.2 LB/MBF	BACT-OTHI	
MS-0048	INTERNATIONAL PAPER COMPANY MORTON LUMBER MILL	DRY KILNS, NO. 1, 2, & 3	WOOD	52550 MBF/YR	VOC	N		5.2 LB/MBF	BACT-OTHI	
MS-0054	WEYERHAEUSER COMPANY	KILN, DRY LUMBER, AA-007	WOOD	35 MMBF/YR	VOC	P	THROUGHPUT LIMIT, NO ADD ON CONTROLS FEASIBLE.	4.2 LB/MBF	BACT-PSD	
MS-0054	WEYERHAEUSER COMPANY	KILNS, DRY LUMBER, 5	WOOD	222.5 MMBF/YR	VOC	P	ANNUAL THROUGHPUT LIMITS. NO ADD ON CONTROLS FEASIBLE.	4.2 LB/MBF	BACT-PSD	
MT-0016	PLUM CREEK MANUFACTURING, L.P.	WOOD PRODUCTS, MEDIUM DENSITY FIBERBOARD DRYER	WOOD	46500 T/YR	VOC	N		76.1 LB/H	BACT-PSD	
OH-0240	GIVAUDAN FLAVORS	SPRAY DRYER FOR PRODUCING FLAVORS		500 LB/H	VOC	A	REGENERATIVE THERMAL OXIDIZER	0.6 LB/H	BACT-OTHI	
OK-0057	MID AMERICA IND PARK PRYOR	INDUCTION FURNACES (3)		10 T/H EACH	VOC	N	NO ADDTIONAL CONTROLS REQUIRED. SEE POLLUTANT NOTES.		BACT-PSD	
OK-0082	WRIGHT CITY MILL	NO. 3 PINE LUMBER KILN		7.94 MMBF/MO	VOC	N		162.84 T/YR	BACT-PSD	
PA-0165	PROCTER & GAMBLE PAPER PRODUCTS COMPANY	ROTAGRAVURE PRINTING OPERATION WITH DRYER	NATURAL GAS	500 F/MIN	VOC	A	TOTAL ENCLOSURE WITH RETOX 3.0 REGENERATIVE THERMAL OXIDIZER (RTO). LIMITS ARE PRESENTED FOR INFORMATIONAL PURPOSES ONLY. STANDARDIZED EMISSION UNITS NOT REQUIRED.	3.04 T/YR	OTHER	98.5
SC-0050	CHESTERFIELD LUMBER COMPANY	STEAM HEATED LUMBER DRYING KILN	WOOD WASTE	101 MMBF/D	VOC	N		353.5 LB/D	LAER	
SC-0052	WILLAMETTE - CHESTER DIVISION	LUMBER DRY KILN		170 MBF/CHARGE	VOC	N		3.8 LB/MBF	BACT-PSD	
SC-0059	COLLUM'S LUMBER MILL	KILN, 2 STEAM HEATED, LUMBER	WOOD WASTE	55.75 MMBF/YR	VOC	N		195 T/YR	LAER	
SC-0074	KRONOTEX	DRYER, MDF, TUBE	NAT GAS	454611 ODT/YR	VOC	A	RTO WITH 100% CAPTURE & 95% EFF.	18.16 LB/H	LAER	95
SC-0074	KRONOTEX	DRYER, PB, ROT, SINGLE PASS	NAT GAS	578861 ODT/YR	VOC	A	RTO WITH 100% CAPTURE & 95% EFF.	29.6 LB/H	LAER	95

WI-0140	QUAD GRAPHICS, INC.	DRYING OVEN,4 COLOR HEATSET WEB DRYER OFFSET PRESS	NATURAL GAS	138.89 LB/H (INK)	VOC	A	THERMAL OXIDIZER MEGTEG SUMMIT II (MIN 1400 DEG. F) CATALYTIC OXIDIZER MEGTEG MAGNUM 14000 (MIN 650 DEG. F). PERMIT LIMIT IS CONTROL METHOD & RESULTING CONTROL EFF. NO LIMITS ON VOC CONTENT.	57.9 T/YR	BACT-PSD	97.5
WY-0031	GENERAL CHEM SODA ASH PARTNERS - GEN CHEM SODA	CALCINER, TRONA, 2 EACH		145 T/H TRONA 1 FE	VOC	N		0	BACT-PSD	0
WY-0031	GENERAL CHEM SODA ASH PARTNERS - GEN CHEM SODA	CALCINER, TRONA, 5 EACH		65 T/H TRONA 1 FE	VOC	N		0	BACT-PSD	0
WY-0034	SOLVAY SODA ASH JOINT VENTURE TRONA MINE/SODA ASH	CALCINER, NATURAL GAS FIRED TRONA	NATURAL GAS	275 T/H TRONA ORE	VOC	N		533.5 LB/H	BACT-PSD	0
WY-0036	OCI, WYOMING L.P.-OCI SODA ASH PLANT	CALCINER TRONA ORE, NATURAL GAS FIRED	NATURAL GAS	213 T/H ORE FEED R	VOC	N		44.04 LB/H	BACT-PSD	0

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ENGINEERING CALCULATIONS	SUBJECT: Cost Analysis - Max Heat Recovery	DATE: April 21, 2003		

Physical Parameters for Cost Analysis **(values in shaded boxes are input. Remainder are calculated)**

Waste gas exhaust flow				
Actual flow rate	650,000	ACFM		
Exhaust temp. T_{wi}	350	F		
Ref. Temp	77	F[a]		
Standard flow rate Q_w	431,000	SCFM (77F)		
Conversion Factor	391.9	SCF/lb-mol (77F)		
Exhaust gas MW	28.97	[b]		
H2O MW	18			
Exhaust H2O	18.5%	4/7/2003 Email from Dolly Potter Solvey		
Mass flow, M_w	1,777,751	lb/hr		
Waste gas O2 content	12%	- assumed sufficient for combustion, no dilution required.		
Percent of LEL				
VOC emission rate	256	lb/hr	0.8 lb/ton (from attached stack tests)	
VOC average MW	100			
VOC flow rate	17	SCFM		
VOC vol %	0.004%			
Average LEL	1%	[c]		
Percent of LEL	0.4%	- well below 25% threshold, no dilution required.		
Heat of combustion of waste gas stream				
VOC average heat of comb.	20,000	BTU/lb[d]		
Waste gas heat of comb., H_w	2.9	BTU/lb		
Temp. of waste gas exiting the preheater	Thermal Regenerative		Catalytic Fixed Bed	
Fraction of energy recovered, ER	95%	[e]	70%	[i]
Thermal incinerator oper. temp. Tf_i	1600	F[b]	900	F[i]
Control efficiency	98%	[b]	95%	[i]
T_{wo} = ER * (T_{fi} - T_{wi}) + T_{wi}	1,538	F[f]	735	F[f]
Auxiliary fuel requirement				
Cp_w	0.303	BTU/lb[g]	0.288	BTU/lb[g]
Heat in - M_w*Cp_w*(T_{wo}-T_{ref}), H_i	787	MMBtu/hr	337	MMBtu/hr
Heat out - M_w*Cp_w*(T_{wi}-T_{ref}), H_o	820	MMBtu/hr	421	MMBtu/hr
Losses, H_l 10%	82	MMBtu/hr	42	MMBtu/hr
Heat of waste gas comb., H_c	5	MMBtu/hr	5	MMBtu/hr
Heat of aux. fuel, H_{af} = H_o-H_i-H_c+H_l	111	MMBtu/hr	121	MMBtu/hr
Heat of comb. of N.G., Hg	21,502	BTU/lb[h]	21,502	BTU/lb[h]
Mass of auxiliary fuel required	5,143	lb/hr	5,650	lb/hr
density of N.G.	0.0408	lb/SCF[h]	0.0408	lb/SCF[h]
Volume of N.G. required, Q_a	2,101	SCFM	2,308	SCFM

Reference

a. *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA/452/B-02-001, January 2002, Sec. 3.2, Ch. 2, p. 2-18.
b. *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA/452/B-02-001, January 2002, Sec. 3.2, Ch. 2, p. 2-23.
c. *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA/452/B-02-001, January 2002, Sec. 3.2, Ch. 2, p. 2-53.
d. *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA/452/B-02-001, January 2002, Sec. 3.2, Ch. 2, p. 2-55.
e. *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA/452/B-02-001, January 2002, Sec. 3.2, Ch. 2, p. 2-37.
f. *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA/452/B-02-001, January 2002, Sec. 3.2, Ch. 2, p. 2-24.
g. Mean heat capacity of air with 18.5% water. Elementary Principles of Chamical Engineering, 2nd Ed., Felder and Rousseau, 1986.
h. *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA/452/B-02-001, January 2002, Sec. 3.2, Ch. 2, p. 2-27.
i. *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA/452/B-02-001, January 2002, Sec. 3.2, Ch. 2, p. 2-30.

Air Sciences Inc. **ENGINEERING CALCULATIONS**	PROJECT TITLE: SOLVAY - SOURCE 17 BACT for VOC	BY: Kevin Lewis		
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	SUBJECT: Cost Analysis - Max Heat Recovery	DATE: April 21, 2003		

Physical Parameters for Cost Analysis **(values in shaded boxes are input. Remainder are calculated)**

	Thermal Regenerative	Catalytic Fixed Bed
Total Flow		
$Q_{tot} = Q_w + Q_a$	433,101	433,308
Power requirement for fan		
Pressure loss, P	27 [a], extrapolated	21 [a]
Efficiency	60% [b]	60% [b]
$kW = (1.17E\text{-}4 * Q_{tot} * P) / E$	2,269	1,765
Volume of catalyst bed		
Space velocity, base metal oxide	-	10,000 h^{-1} [c]
Space velocity, noble metal	-	35,000 h^{-1} [c]
$Q_{tot\,(60F)}$	-	417,000 SCFM (60F)
$V_{cat} = Q_{tot\,(60F)} / SV$	-	2,502 ft^3, base metal oxide
$V_{cat} = Q_{tot\,(60F)} / SV$	-	715 ft^3, noble metal

Emission Rates

Hours of operation 8,760 hr/yr

VOC emissions 1,121 ton/yr

Emission Reductions	Thermal Regenerative	Catalytic Fixed Bed
VOC reduction	1,099 ton/yr	1,065 ton/yr

Production

Trona feed rate 320 tph

Soda ash production rate 200 tph

Duct work diameter

Velocity, u = 6000 [d]

$D = 1.128 * (Qtot / u)^{1/2}$ 9.6 ft 115 in

Duct work friction loss/pressure drop

Duct length, L 100 ft

$Fd = 0.136 * (1/D)^{1.18} * (u/1000)^{1.8} * (L/100)$ 0.24 in. w.c.

Number of 90° elbows, N_{90} 3 Friction loss factor for 90°, k_{90} 0.33 [f]

Number of 45° elbows, N_{45} 3 Friction loss factor for 90°, k_{45} 0.165 [f]

$Fe = \Sigma N * k * (u/4016)^2$ 3.31 in. w.c.

$kW = 1.175E\text{-}4 * Q_{tot} * (F_d + F_e) / E =$ 301 kW [f]

Duct, elbow, damper cost

Duct cost, C_d	$C_d = aD^b$	a =	1.55	b =	0.936	D =	115 in, actual size	C = $ 131.6 /ft [g]
Elbow cost, C_e	$C_d = ae^{bD}$	a =	53.5	b =	0.0633	D =	78 in, max. in range	C = $ 7,458 /elbow [g]
Damper cost, C_p	$C_p = ae^{bD}$	a =	45.4	b =	0.0597	D =	78 in, see above	C = $ 4,780 /damper [g]

Reference

a. *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA/452/B-02-001, January 2002, Sec. 3.2, Ch. 2, p. 2-46.
b. *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA/452/B-02-001, January 2002, Sec. 3.2, Ch. 2, p. 2-43.
c. *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA/452/B-02-001, January 2002, Sec. 3.2, Ch. 2, p. 2-35.
d. *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA/452/B-02-001, January 2002, Sec. 2, Ch. 1, p. 1-29.
e. *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA/452/B-02-001, January 2002, Sec. 2, Ch. 1, p. 1-33.
f. *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA/452/B-02-001, January 2002, Sec. 2, Ch. 1, p. 1-35, 51.
g. *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA/452/B-02-001, January 2002, Sec. 2, Ch. 1, p. 1-45, 46.

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Cost Item[a]			Cost, $ Thermal Regen., 95%	Cost, $ Fixed-Bed Catalytic, 70%
Direct Costs				
Purchased equipment costs				
Incinerator (EC)			$ 5,231,000 [b]	$ 1,882,000 [b]
Auxiliary equipment	100 ft duct	$ 131.6 /ft	13,000	13,000
	6 elbows	$ 7,458 /elbow	45,000	45,000
	1 damper	$ 4,780 /damper	5,000	5,000
Sum (1988 Dollars)			5,294,000	1,945,000
Escalation Factors (1988 - 2003)			1.236 [c]	1.309 [c]
Sum = A (2003 Dollars)			6,543,384	2,546,005
Instrumentation, 0.1 A			654,338	254,601
Sales taxes, 0.03 A			196,302	76,380
Freight. 0.05 A			327,169	127,300
Purchased equipment cost, B			$ 7,721,000	$ 3,004,000
Direct installation costs				
Foundations & supports, 0.08 B			617,680	240,320
Handling & erection, 0.14 B			1,080,940	420,560
Electrical, 0.04 B			308,840	120,160
Piping, 0.02 B			154,420	60,080
Insulation for ductwork, 0.01B			77,210	30,040
Painting, 0.01 B			77,210	30,040
Direct installation costs			$ 2,316,000	$ 901,000
Site preparation			-	-
Buildings			-	-
Total Direct			**$ 10,037,000**	**$ 3,905,000**
Indirect Costs (installation)				
Engineering, 0.10 B			1,003,700	390,500
Construction and field expenses, 0.05 B			501,850	195,250
Contractor fees, 0.10 B			1,003,700	390,500
Start-up, 0.02 B			200,740	78,100
Performance test, 0.01 B			100,370	39,050
Contingencies, 0.03 B			301,110	117,150
Total Indirect Costs			3,111,000	1,211,000
Total Capital Investment before retrofit cost considerations (rounded)			**13,148,000**	**5,116,000**
Retrofit cost, 0.1 TCI			1,315,000	512,000 [d]
Total Capital Investment (rounded)			**$ 14,463,000**	**$ 5,116,000**

Reference

[a] *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA/452/B-02-001, January 2002, Sec. 3.2, Ch. 2, p. 2-44.

[b] *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA/452/B-02-001, January 2002, Sec. 3.2, Ch. 2, p. 2-38.

RTO $EC = 2.204 * 10^5 + 11.57\ Q_{tot}$

Cat., Fixed, 70% HR $EC = 1443\ Q_{tot}^{0.5527}$

F.O.B. 1999 Dollars

[c] William M. Vatavuk, P.E., Vatavuk Engineering, April 10, 2003, letter to Kevin Lewis, Air Sciences. Inc.

[d] *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA/452/B-02-001, January 2002, Sec. 1, Ch. 2, p. 2-28, 29.

Air Sciences Inc.	PROJECT TITLE: SOLVAY - SOURCE 17 BACT for VOC	BY: Kevin Lewis		
ENGINEERING CALCULATIONS	PROJECT NO: 170-4-2	PAGE: 4	OF: 4	SHEET: 1
	SUBJECT: Cost Analysis - Max Heat Recovery	DATE: April 21, 2003		

Cost Item[a]	Suggested Factor[a]	Unit Cost[a]		Thermal Regen., 95%	Fixed-Bed Catalytic, 70%
Direct Annual Costs, DC	**8,760 hr/yr**				
Operating Labor					
Operator	0.5 hr/shift	$12.95/hr		7,090	7,090
Supervisor	15% of operator			1,064	1,064
Operating Materials	-				
Maintenance					
Labor	0.5 hr/shift	$14.95/hr		8,185	8,185
Materials	100% of maintenance labor			8,185	8,185
Catalyst replacement	100% of catalyst replaced	$650/ft³ metal oxide	55.31%	-	899,507
Utilities					
Natural Gas		$4.00/kft³[a,b]		4,416,892	4,852,727
Electricity		$0.059/kWh		1,172,821	912,194
Electricity for ductwork pressure loss		$0.059/kWh		155,722	155,722
Total DC				**$ 5,770,000**	**$ 6,845,000**
Indirect Annual Cost, IC					
Overhead	60% of sum of operating, supervisor, & maintenance labor & maintenance materials			14,714	14,714
Administrative Charges	2% TCI			289,260	102,320
Property Taxes	1% TCI			144,630	51,160
Insurance	1% TCI			144,630	51,160
Capital recovery	CRF [TCI - 1.08 (cat. Cost)]	14.24%		2,059,531	728,518
				$ 2,653,000	**$ 948,000**
Total Direct Cost (rounded)				**$ 8,423,000**	**$ 7,793,000**
VOC Reduction (ton/yr)				1,099	1,065
Average Cost for VOC Reduction ($/ton VOC removed)				**$ 7,660**	**$ 7,320**
Average Cost for VOC Reduction ($/ton-soda ash)				**$ 4.81**	**$ 4.45**

Catalyst Replacement:	2 years	7.0%	=	55.31% CRF = (i * (1+i)^n)/((1+i)^n - 1)
Initial Capital Investment:	10 years	7.0%	=	14.24% CRF = (i * (1+i)^n)/((1+i)^n - 1)

Reference

[a] *EPA Air Pollution Control Cost Manual*, Sixth Edition, EPA/452/B-02-001, January 2002, Sec. 3.2, Ch. 2, p. 2-45.

[b] 4/7/2003 Email from Dolly Potter, Solvey.

Vatavuk Engineering

(Creators of the VAPCCI)

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April 10, 2003

Mr. Kevin Lewis
Air Sciences, Inc.
1301 Washington Avenue
Suite 200
Golden, CO 80401

Re: Escalation of *EPA Air Pollution Control Cost Manual* Incinerator Costs

Dear Kevin:

At your request, I have obtained the data necessary to escalate the catalytic incinerator and regenerative thermal oxidizer (RTO) equipment costs in the present (2002) edition of the *EPA Air Pollution Control Cost Manual* to current dollars. To make these escalations, I used the VAPCCI's (Vatavuk Air Pollution Control Cost Indexes) for catalytic incinerators and RTO's, plus data I collected when developing these indexes.

First of all, the Manual incinerator costs are mislabeled. The figures on which the equipment costs are plotted against volumetric flowrate (*i.e.,* figures 2.4 through 2.8) indicate that the costs are expressed in 1999 dollars. However, after comparing these figures and the underlying cost equations to those in the previous (1996) edition of the Manual, I found that both sets of figures and equations were *identical*. Moreover, the costs in the 1996 edition were in *April 1988* dollars. Thus, the escalation procedure and data presented in this letter are based on escalating the Manual costs from April 1988, not from 1999.

The VAPCCI's for catalytic incinerators and RTO's are listed in boldface in the table below, along with the VAPCCI's for seven other air pollution control device categories.[1] Updated quarterly, each VAPCCI is used to escalate the base equipment cost for each type of device. A VAPCCI is calculated from BLS (Bureau of Labor Statistics) inputs, mainly Producer Price Indexes. Note in the table that annual average indexes are given for the years 1999, 2000, and 2001, while quarterly VAPCCI's are listed for first through fourth quarter 2002 and first quarter 2003. Also note that the indexes for both fourth quarter 2002 and first quarter 2003 are *preliminary*. In particular, the first quarter 2003 VAPCCI's are "pre-preliminary," as they are based on only two months of BLS inputs (January and February 2003),

[1] Originally, there were VAPCCI's for fabric filters and mechanical collectors. However, these indexes were discontinued in 2001.

where three months of data are required to calculate a quarterly VAPCCI. The March 2003 inputs are not yet available and will not be until later this month. Nevertheless, as long as it is understood that the first quarter 2003 VAPCCI's are tentative and could differ considerably from the final indexes, they can be used to escalate control equipment costs in this case.

Another fact that needs to be emphasized: The VAPCCI's were not created until 1994. Specifically, the base value of the indexes is 100.0 (first quarter 1994). That being the case, how can we escalate costs from earlier years, such as 1988? Fortunately, when I developed the indexes I surveyed incinerator equipment vendors to determine how much their prices had changed over the period 1989-94. Hence, using these vendor data and the VAPCCI's, one can readily escalate costs from 1989 to later years. Finally, for the period April 1988 through first quarter 1989, I just extrapolated backward from first quarter 1989, based on these vendor data. The overall escalation calculation was the product of three escalation factors (EF):

EF (overall) = EF (April '88 to 1st Q'89) x EF (1st Q'89 to 1st Q'94) x EF (1st Q'94 to 1st Q'03)

Again, the first two EF's are based on incinerator vendor data, while the third EF is just the VAPCCI divided by 100.0. In other words:

EF (overall)—catalytic incinerators = 1.0131 x 1.067 x (121.1/100.0) = **1.309**

EF (overall)—regenerative thermal oxidizers = 1.0043 x 1.089 x (113.0/100.0) = **1.236**

Based on these EF's, the price of catalytic incinerators and RTO's would have increased by about 31% and 24%, respectively, over the 1988-2003 period. For instance, if a catalytic incinerator's equipment cost were $100,000 in first quarter 1988 dollars, that same incinerator would cost $130,900 in first quarter 2003 ($100,000 x 1.309). Notice that even though both catalytic incinerators and RTO's are members of the oxidizer "family," their prices changed somewhat differently over this 15-year period. Clearly, it would not be advisable to use a single index to escalate prices for all incinerators.

Keep in mind, of course, that prices calculated from escalation factors are merely *estimates*. They should not be considered as credible as vendor quotes. In fact, the generally accepted time limit for cost escalations is *five* years. If cost data are older than five years, it is usually better to obtain current prices from vendors or other reliable sources. On the other hand, it is often difficult, time-consuming, and expensive to obtain vendor prices. Often, the best that the cost estimator can do is apply escalation factors to the best and most recent price data he/she has available.

I hope that this letter supplies the information you need. If not, or if you have any questions, please do not hesitate to contact me.

Warmest regards,

William M. Vatavuk, P.E.
President

VATAVUK AIR POLLUTION CONTROL COST INDEXES

Date Prepared: April 9, 2003

Control Device	Vatavuk Air Pollution Control Cost Indexes (first quarter 1994 = 100.0)[2]							
	1999 (Avg.)	2000 (Avg.)	2001 (Avg.)	1st Q'02	2nd Q'02	3rd Q'02	4th Q'02[3]	*1st Q'03*[4]
Carbon adsorbers	100.8	108.0	105.9	104.6	105.5	108.5	108.6	*109.0*
Catalytic incinerators	102.9	114.3	112.9	110.2	114.1	115.2	119.7	***121.1***
Electrostatic precipitators	101.2	101.1	98.5	98.8	100.2	103.0	104.2	*102.8*
Fabric filters	111.7	113.0	NA5	NA	NA	NA	NA	*NA*
Flares	99.4	104.3	100.8	98.6	101.0	103.2	103.6	*103.4*
Gas absorbers	110.9	112.9	114.4	114.7	115.3	116.3	116.7	*116.4*
Mechanical collectors	119.6	121.8	NA[3]	NA	NA	NA	NA	*NA*
Refrigeration systems	105.7	106.1	105.8	105.5	106.2	107.0	107.6	*107.7*
Regenerative thermal oxidizers	108.1	109.0	110.7	111.1	111.1	112.5	113.1	***113.0***
Thermal incinerators	108.1	107.9	107.9	107.8	107.9	109.0	109.6	*109.5*

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[2] Index values have been rounded to the nearest tenth.

[3] All fourth quarter 2002 indexes are *preliminary*.
[4] All first quarter 2003 indexes are "pre-preliminary," in that they are based on PPI inputs from just *two* months (January and February 2003).
[5] Effective second quarter 2001, the Bureau of Labor Statistics abolished the Producer Price Indexes (PPI's) for fabric filters and mechanical collectors. As the VAPCCI's for these two control devices were, essentially, their PPI's, the VAPCCI's can no longer be reported.

Wet scrubbers	108.8	113.8	111.3	111.6	112.5	113.9	113.9	*115.9*

ESP Retrofit Cost Estimate for 0.015 Gr/DSCF
Solvay Minerals, Inc.
Calciners A & B Fuel Switch
Precipitators EP -1 and EP-2
AP-0631

Main Reference:

EPA Air Pollution Control Cost Manual - Sixth Edition (EPA 452/B-02-001)

Section 6 - Particulate Matter Controls

Chapter 3 - Electrostatic Precipitators 7-10-02

Notes:

This cost analysis is directed to evaluating the cost of supplementing the collection area of the existing system to meet 0.015 Gr/DSCF.

Solvay Minerals, Inc. has determined that is is more cost effective to add collection area to the existing ESP's rather than to replace entirely.

Basis

			Reference
1	Of <u>two</u> precipitators is used in basis of calculations		
325,000	ACFM calciner offgas		*Permit Application*
156,407	SCFM @ 60F calciner offgas		*Calculated*
120,000	DSCFM @ 60F calciner offgas		*Permit Application*
400	Deg F flue gas temperatrue		*Permit Application*
11.70	Ambient atmos pressure, psia		*Ambient Pressure Data*
14.70	Std atmos pressure		*Standard Atmospheric Pressure*
20.6	Pph particulate emission at 0.02 gr/dscf		*Permit Application*
$	Dollars expressed in USD		

Existing Equipment

2	Buell Model BA 1.1X50L4334-4.T, plate and weighted wire, purchased August 11, 1981, handling calcined ore (soda ash) dust (90 - 95%), fly ash, silica, shale, shortite (5 - 10%)		*Purchase Order 037-1268-000-01400 Specifications*
8	Gr/DSCF inlet loading		*Assumed*
0.02	Gr/DSCF existing guaranteed outlet loading		*Stack test results (from archives, operating with coal)*
99.75	Guaranteed efficiency percent		*Calculated and PO specifications*
4.52	Gas velocity ft/sec		*Calculated*
1199	Cross sectional area sq ft		*PO specifications*
0.24	Migration velocity ft/sec (from Buell design criteri	7.33 cm/sec	*PO specifications*
115,200	Total collecting plate area installed		*PO specifications*
354	SCA collecting area/1000 ACFM installed		*PO specifications*
1.125	Aspect ratio installed		*PO specifications*

Desired Efficiency to Achieve 0.015 Gr/DSCF

8	Gr./DSCF inlet loading	*Assumed*
0.015	Gr./DSCF existing guaranteed outlet loading	*Assumed*
99.8125	Desired efficiency percent	*Calculated*

Cost Calculations for Specific Collecting Area (SCA) to Achieve 0.015 Gr/DSCF

Design SCA

	SCA = -ln(1-efficiency %)/migration velocity	*EPA Air Pollution Cost Manual*
0.857	SCA (s/cm) 85.7 s/m	*calculated*
435	ESCA (sq ft/1000 acfm)	*calculated*
141,434	Total Collector Plate area (sq ft)	*calculated*
115,200	Existing Collector Plate area (sq ft)	*calculated*
26,234	Net New Collector Plate area (sq ft)	*calculated*

ESP Cost

500,000	Flange-to-flange equipment cost from Figure 3.5 (upper curve, includes standard options), 1987 $ *	*EPA Air Pollution Cost Manual*
	* Note: costs have not changed significantly since 1987	
1.3	Factor for retrofit (1.3 to 1.5 is suggested, based on difficulty)	*EPA Air Pollution Cost Manual*
650,000	Adjusted equipment cost for retrofit	*Calculated*
1.18	Factor for instrumentation, sales tax, freight	*EPA Air Pollution Cost Manual*
845,000	Purchased equipment cost, PEC	*Calculated*

Auxilliaries Cost

40,000	Additional dust screw conveyors	*Cost Estimate*

Total Capital Investment

2.24	Factor for direct and indirect installation costs (DC + IC)	*EPA Air Pollution Cost Manual*
	(This assumes the new equipment will fit existing space. Site preparation and building costs are assumed to be negligible.)	
1,982,400	**Total Capital Investment TCI (each precipitator)**	*Calculated*

Annual Costs Pressure Drop

0	Minimal -- neglect	*Estimated*

Total Annual Cost

	DIRECT	
0	Operating labor -- negligible	*Estimated*
4,125	Maintenance labor $4125 for collector area < 50,000 sq ft	*EPA Air Pollution Cost Manual*
8,450	Maintenance material 1% of PEC	*EPA Air Pollution Cost Manual*
14,951	Operating electricity based on .00194 kWh per sq ft collecting area and 3.4 cents per kWh	*EPA Air Pollution Cost Manual*
27,526	Total Direct Cost (DC)	
	INDIRECT	
7,545	Overhead 60% of op labor, maint labor, and maintenance material	*EPA Air Pollution Cost Manual*
39,648	Administrative charges 2% of total capital investment TCI	*EPA Air Pollution Cost Manual*
19,824	Property tax 1% of TCI	*EPA Air Pollution Cost Manual*
19,824	Insurance 1% of TCI	*EPA Air Pollution Cost Manual*
	EPA Section 1, Chapter 2, page 2-21	*EPA Air Pollution Cost Manual*
	Life of project 20 years	*EPA Air Pollution Cost Manual*
	Interest rate = 7 %	*Interest rate per Stephen Kovar, Solvay Minerals, Inc.*
	CRF = i(1 +i)nth power/((1 + i)nth power -1)	*EPA Air Pollution Cost Manual*
	1 + i = 1.07	*Calculated*
	CRF = 0.094393	*Calculated*
187,125	Capital recovery assumin; 0.09439 , interest = 7 %	*Calculated*
273,966	Total Indirect Cost (IC)	
301,491	**Total Annual Cost (each precipitator)**	
301,000	**Total Annual Cost (rounded, each precipitator)**	

Particulate Emissions

90.1	Annual tons particulate emissions at existing 0.02 gr/dscf (one ESP, 20.6 pph)	*Calculated*
67.6	Annual tons particulate emissions contolled to 0.015 gr/dscf (one ESP, 15.4 pph)	*Calculated*
22.5	Additional annual tons particulate emission controlled (one ESP)	*Calculated*

Cost Effectiveness

$13,362	**USD per ton of particulate removed**	*Calculated*

NOx Control Cost Estimates for Solvay Minerals, Inc. Calciners A & B Fuel Switch OP 30-126 AP-0631

Main References:

CFD Modeling Stoker Fired Calciner Furnace
Detroit Stoker Company Job No. ES-111
dated 8/6/2002

Detroit Stoker Company Specifications and Proposal No. P-RG-7447-1A
dated 10/30/02

Notes:

This cost analysis is directed to addressing the incremental economic cost of controlling calciner coal furnace NOx emissions with water injection (WI) and flue gas recirculation (FGR) systems.

Solvay Soda Ash JV has determined that Detroit Stoker design calciner coal furnaces with WI and FGR are available and feasible technology with the lowest NOx emission rate.

Basis

		Source
1	Of two calciner furnaces is used in basis of calculations	*Permit Application*
325,000	ACFM calciner offgas	*Permit Application*
156,407	SCFM @ 60F calciner offgas	*Calculated*
120,000	DSCFM @ 60F calciner offgas	*Permit Application*
400	Deg F flue gas temperatrue	*Permit Application*
200	Furnace heat input MM Btu/h (HHV)	*Detroit Stoker Specification*
1,752,000	Furnace heat input MM Btu/Y (HHV)	*Calculated from Permit Application*
5	No. of stokers each	*Detroit Stoker Specification*
100	Percent excess air in furnace	*Detroit Stoker Specification*
1,800	Furnace outlet temperature deg F	*Detroit Stoker Specification*
30	Flue Gas Recirculation (FGR) % of calciner offgas	*Detroit Stoke Specification*
50,000	Flue Gas Recirculation rate ACFM	*Calculated from Detroit Stoke Specification*
113,000	Flue Gas Recirculation rate lb/H	*Calculated from Detroit Stoke Specification*
15	Water Injection (WI) injection rate gpm	*Detroit Stoke Specification*
10,000	Water Injection injection rate lb/H	*Calculated from Detroit Stoke Specification*
11.70	Ambient atmos pressure, psia	*Ambient Pressure Data*
14.70	Std atmos pressure	*Standard Atmospheric Pressure*
$	Dollars expressed in USD	

Total Equipment

2	Bigelow-Liptak refractory lined furnaces with Detroit Stoker RotoGrate Stokers. handling calcined ore (soda ash) dust (90 - 95%), fly ash, silica, shale, shortite (5 - 10%)	*Proposal No. P-RG-7447-1A, October 30, 2002*
2	Overfire Air Turbulence System (standard)	*Proposal No. P-RG-7447-1A, October 30, 2002*
2	Flue Gas Recirculation System	*Proposal No. P-RG-7447-1A, October 30, 2002*
2	Water Injection System	*Proposal No. P-RG-7447-1A, October 30, 2002*

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Performace to Achieve 0.45 lb Nox / MM Btu

0.79	Nox emission rate revised OFA configuration lb/MM Btu input	*Permit Application and Proposal P-RG-7447-1A, 10/30/02*
0.518	Nox emission rate with FGR lb/MM Btu input	*Calculated, DSC 4/24/2003, 80% NOx reduction due FGR*
0.45	Nox emission rate with FGR + WI lb/MM Btu input	*Detroit Stoker Emission Guarantee with FGR and WI*
692	Nox emission rate revised OFA configuration, tons/Y	*Calculated*
238	Nox emission reduction with FGR, tons/Y	*Calculated*
60	Nox emission reduction with WI, tons/Y	*Calculated*
298	Total Nox emission reduction, tons/Y	*Calculated*
788	Resulting total Nox emission, two calciners, tons/Y	*Permit Application*

Cost Estimates of Nox Reduction Equipment to Achieve 0.45 lb Nox / MM Btu

Equipment Cost FGR System

277,694	FGR System equipment cost, undergrate and overfire air, inc. fans, motors, dampers, ductwork, supports, manifolds and nozzles.	*DSC 4/24/2003; Proposal P-RG-7447-1A, 10/30/2002*
1.3	Factor for retrofit (1.3 to 1.5 is suggested, based on difficulty)	*EPA Air Pollution Cost Manual*
361,002	Adjusted equipment cost for retrofit	*Calculated*
1.18	Factor for instrumentation, sales tax, freight	*EPA Air Pollution Cost Manual*
469,302	Purchased equipment cost, PEC	*Calculated*

Auxilliaries Cost

0	None	*Estimated*

Total Capital Investment

2.24	Factor for direct and indirect installation costs (DC + IC) (Based on the new equipment fitting existing space. Site preparation and building costs are assumed to be negligible.)	*EPA Air Pollution Cost Manual*
1,051,237	**Total Capital Investment TCI (FGR each furnace)**	*Calculated*

Annual Costs Pressure Drop, Moving FGR from ID Fan Breech to Furnace

200	FGR fan power consumption, HP	*DSC 4/24/2003; Proposal P-RG-7447-1A, 10/30/2002*
0.7457	KW consumption / HP	*Unit Conversion*
1,306,466	KWH/Y	*Calculated*
0.0345	Electrical rate, $/KWH	*Solvay 2003 YTD actual cost*
45,073	Annual power cost for FGR	*Calculated*

Total Annual Cost

	DIRECT	
0	Operating labor -- negligible	*Estimated*
4,000	Maintenance labor four persons 20 hr/Y, $50/Hr.	*Estimated*
4,693	Maintenance material 1% of PEC	*EPA Air Pollution Cost Manual*
8,693	Total Direct Cost (DC)	
	INDIRECT	
5,216	Overhead 60% of op labor, maint labor, and maintenance material	*EPA Air Pollution Cost Manual*
21,025	Administrative charges 2% of total capital investment TCI	*EPA Air Pollution Cost Manual*
10,512	Property tax 1% of TCI	*EPA Air Pollution Cost Manual*
10,512	Insurance 1% of TCI	*EPA Air Pollution Cost Manual*
	EPA Section 1, Chapter 2, page 2-21	*EPA Air Pollution Cost Manual*
	Life of project n 20 years	*EPA Air Pollution Cost Manual*
	Interest rate = 7 %	*Interest rate per Stephen Kovar, Solvay Minerals, Inc.*
	CRF = i(1 +i)nth power/((1 + i)nth power -1)	*EPA Air Pollution Cost Manual*
	1 + i = 1.07	*Calculated*
	CRF = 0.094393	*Calculated*
99,229	Capital recovery assuming ' 0.09439 , interest = 7 %	*Calculated*
146,495	Total Indirect Cost (IC)	
200,261	**Total Annual Cost FGR (each furnace)**	
200,000	**Total Annual Cost FGR (rounded, each furnace)**	

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Equipment Cost WI System

39,584	WI System equipment cost, including header solenoid valves, and spray nozzles. (system will use existing plant water pump)			*DSC 4/24/2003; Proposal P-RG-7447-1A, 10/30/2002*
1.3	Factor for retrofit (1.3 to 1.5 is suggested, based on difficulty)			*EPA Air Pollution Cost Manual*
51,459	Adjusted equipment cost for retrofit			*Calculated*
1.18	Factor for instrumentation, sales tax, freight			*EPA Air Pollution Cost Manual*
66,896	Purchased equipment cost, PEC			*Calculated*

Auxilliaries Cost

0	None			*Estimated*

Total Capital Investment

2.24	Factor for direct and indirect installation costs (DC + IC) (Based on the new equipment fitting existing space. Site preparation and building costs are assumed to be negligible.)			*EPA Air Pollution Cost Manual*
149,847	**Total Capital Investment TCI (WI each furnace)**			*Calculated*

Annual Costs Evaporation and Pumping of Water to Furnace

	PUMPING			
15	GPM water flow			*DSC 4/24/2003; Proposal P-RG-7447-1A, 10/30/2002*
2	Pump power consumption, HP			*Pump manual*
0.7457	KW consumption / HP			*Standard conversion*
13,065	KWH/Y			*Calculated*
0.0345	Electrical rate, $/KWH			*Solvay 2003 YTD actual cost*
451	Annual power cost for water pump			*Calculated*
	EVAPORATION			
15	Water Injection GPM flow			*DSC Proposal No. P-RG-7447-1A, October 30, 2002*
	Calciner Energy Consumption *	w/Water Injection	w/o Water Injection	*Solvay Material and Energy Balance:*
	Purchased MMBTU/Ton Ore	1.158	1.1074	*Solvay Material and Energy Balance:*
	* for the same furnace offgas temperature.			
	Fuel cost $/ton coal	22.00	22.00	
	Fuel cost $/ton ore	1.23	1.18	
	Fuel Cost $/Day	4719	4513	
	Fuel cost $/Y	1,463,974	1,400,192	
63,782	Annual Water Injection Energy Cost Compared to Standard Furnace			

Total Annual Cost

	DIRECT		
0	Operating labor -- negligible		*Estimated*
2,000	Maintenance labor two persons 20 hr/Y, $50/Hr.		*Estimated*
669	Maintenance material 1% of PEC		*EPA Air Pollution Cost Manual*
2,669	Total Direct Cost (DC)		
	INDIRECT		
1,601	Overhead 60% of op labor, maint labor, and maintenance material		*EPA Air Pollution Cost Manual*
2,997	Administrative charges 2% of total capital investment TCI		*EPA Air Pollution Cost Manual*
1,498	Property tax 1% of TCI		*EPA Air Pollution Cost Manual*
1,498	Insurance 1% of TCI		*EPA Air Pollution Cost Manual*
	EPA Section 1, Chapter 2, page 2-21		*EPA Air Pollution Cost Manual*
	Life of project n	20 years	*EPA Air Pollution Cost Manual*
	Interest rate =	7 %	*Interest rate per Stephen Kovar, Solvay Minerals, Inc.*
	CRF = i(1 +i)nth power/((1 + i)nth power -1)		*EPA Air Pollution Cost Manual*
	1 + i =	1.07	*Calculated*
	CRF =	0.094393	*Calculated*
14,145	Capital recovery assuming ' 0.09439 , interest = 7 %		*Calculated*
21,740	Total Indirect Cost (IC)		
88,642	**Total Annual Cost WI (each furnace)**		
89,000	**Total Annual Cost WI (rounded, each furnace)**		

SUMMARY

Nox Emissions

692	Nox emission rate revised OFA configuration, tons/Y	*Calculated*
238	Nox emission reduction with FGR, tons/Y	*Calculated*
60	Nox emission reduction with WI, tons/Y	*Calculated*
298	Total Nox emission reduction, tons/Y	*Calculated*
200,000	**Total Annual Cost FGR (rounded, each furnace)**	*Calculated*
89,000	**Total Annual Cost WI (rounded, each furnace)**	*Calculated*

Cost Effectiveness

$839	**USD per ton of Nox removed, FGR**	*Calculated*
$1,494	**USD per ton of Nox removed, WI**	*Calculated*

Detroit Stoker Company
Subsidiary of United Industrial Corporation
1510 East First Street • PO Box 732 • Monroe, MI 48161-0732
(734) 241-9500 • FAX (734) 241-7126 • E-Mail: sales@detroitstoker.com
www.detroitstoker.com

April 24, 2003

Solvay Minerals Inc.
20 Miles West of Green River
P.O. Box 1167
Green River, Wyoming 82935

Attention: Mr. Bill Stuble

Subject: Solvay Minerals, Inc.
Green River, Wyoming
DSC Proposal No. P-RG-7447-1A

Dear Mr. Stuble:

Following up our telephone conversation of Monday, April 21, 2003, we wish to provide you with the following information:

The power consumption for the flue gas recirculation system is 200 HP. The water requirement for the water injection system is 20 gpm.

Report as previously submitted regarding the water requirements is based on maximum water usage. Once the system is installed and operating, field adjustments to the water quantities maybe required to determine the optimum operating conditions.

With the two (2) NO_x reduction technology, Detroit Stoker Company would expect to see approximately a 43% reduction in NO_x emissions (revised OFA configuration). The flue gas recirculation would provide approximately 80% of the reduction and the remaining 20% from the water injection.

We feel that the RotoGrate Stoker is the best application for this project. The RotoGrate provides the following advantages over other types of firing equipment:

A. Tighter Grates
B. Better Sealing
C. Lower Excess Air
D. Lower Emissions

Based on the an order by December 31, 2003 and shipment first quarter 2005, price for the equipment is outlined in our Specifications and Proposal No. P-RG-7447-1A dated October 30, 2002 is TWO MILLION, FIVE HUNDRED AND NINETY-FIVE THOUSAND, FOUR HUNDRED AND EIGHTY-ONE ($2,595,481.00) DOLLARS, F.O.B. EX WORKS, Monroe, Michigan. The breakdown as requested is as follows:

FGR System	$555,387.00
Water Injection System	$79,167.00
Balance of Equipment	$1,960,927.00

Some of the existing equipment may be reused or modified to accommodate the new equipment. Detroit Stoker Company proposes a site visitation with a Staff Engineer and a Field Service Consultant to determine the condition of the existing equipment. The cost for these services would be at per diem rates. Once the outcome of this inspection is determined, Detroit Stoker Company would advise its findings and the cost impact on the overall project.

We trust the information required at this time, if we can be of any further assistance, please advise.

Sincerely,

Bernd E. Freiny
Sales Department

tsa

cc: Dolly Potter – Solvay Minerals

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Since 1898

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20 Miles West of Green River
P.O. Box 1167
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Sincerely,

Bernd E. Freiny
Sales Department

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cc: Dolly Potter – Solvay Minerals

SUPPLEMENT TO NO_x BACT ANALYSIS

TECHNICAL SUPPORT FOR PERMIT MODIFICATION APPLICATION

CALCINERS A & B FUEL SWITCH

The Solvay permit application AP-0631 contains a summary of control technology selections from the RACT, BACT, LAER Clearinghouse (RBLC) in early 2002, and includes determinations for non-boiler facilities fired on coal or an unspecified fuel. This supplement provides an updated summary as of March 2003, using slightly different filters, and addresses only the determinations for control technologies considered "technically infeasible" in the Solvay application. This updated summary contains the NO_x control technology selections from January 1993 to the present (past 10 years) for coal and unlisted fueling, and all processes under the categories of kilns, calciners, furnaces, and dryers. (The previous analysis included some petroleum refinery processes, which are categorically excluded herein, because the fueling was never by coal.)

The attached flow chart entitled "EPA RBLC for NO_X" depicts the process followed to determine NO_X controls for coal-fired kilns, calciners, dryers, and furnaces. A search for NO_X controls on all kilns, calciners, dryers, and furnaces was conducted, and then all draft determinations and duplicates were removed. The data was further segregated into coal fueling and unspecified fueling. Coal fueled units have unique burner and exhaust stream conditions that affect the feasibility of NO_X controls. They are susceptible to slagging, and have both particulates and some sulfur in the exhaust gas.

The two final summary tables of the workbook are presented below. Table 1 is a summary of RACT, BACT, or LAER (RBL) determinations for kiln, calciner, furnace, and dryers specified as fueled with coal. Table 2 is a summary of the same process units with no fuel specification. It would be necessary to obtain the permit or contact the issuing agency to determine the fuel type for sources listed in Table 2. The details of these determinations are attached and entitled "Coal-Fired Sources: Kilns, Calciners, Dryers, Furnaces" and "Unspecified Fuel – Sources: Kilns, Calciners, Dryers, Furnaces".

Table 1
RBLC NO_x Control Determinations for Kilns, Calciners, Dryers, and Furnaces Fueled with Coal

Listed NO_x Control Technology	Number of Determinations
Good combustion practices	3
Process design	7
Flue gas recirculation	2
Low-NO_x burner	3
SNCR	0
SCR	0
None listed	5
Total	20

SOLVAY2016_1.3_001233

Table 2
RBLC NO_x Control Determinations for Kilns, Calciners, Dryers, and Furnaces with no Fuel Specified

Listed NO_x Control Technology	Number of Determinations
Good combustion practices	15
Process design	9
Flue gas recirculation	1
Low-NO_x burner	29
SNCR	2
SCR	1
None listed	22
Total	79

Of the 20 coal fueled sources listed in Table 1, ten had no add-on controls; three reported good combustion practices and seven reported process design. Process design includes use of pre-heater towers, burner temperature control, and improvement through design technologies. The RotoGrate Stoker coal combustion system proposed in this permit application has process designs to control NO_X emissions. Tight grates and air seals allow accurate control of the air flow to the grate surface and results in lower excess air. The overfire air (OFA) system is staged for thorough mixing of the fuel gases and combustion air in the furnace. These process design parameters result in lower NO_X. There were three determinations listed in Table 1 as low-NO_X burners, which are assumed to be installed on devices where they were determined to be feasible. Low-NO_X burners are generally associated with pulverized coal systems, which have been determined to be "infeasible" for Solvay's application. There were two cases of flue-gas recirculation (FGR), which Solvay considers "feasible" and proposes to install as a NO_X control. There were no determinations of SCR or SNCR, and there were five designations with no control listed.

Table 2 represents sources with unknown fueling and attention is focused only on the determinations which Solvay has determined to be infeasible, which are low-NO_x burners, SCR and SNCR. Low-NO_x burners are ruled as infeasible as noted in the paragraph above. The SCR system is infeasible for Solvay because there is no location in the process where gas conditions are appropriate for its installation (particle-free gas and temperature above 700 F.)

The two SNCR cases are NV-0032 1995 and IA-0027; both permits were issued in 1995. For the Nevada (Clark County) determination, Mr. Steve Dayo (702-455-1675) was contacted on March 19, 2003. This is the Great Star Cement Corporation facility, which was never built, and the permitting records are not readily available (archived). Mr. Dayo recalled that the plant was to be fueled on natural gas and that the SNCR determination was ultimately ruled as "infeasible." Regardless, with natural gas fueling, the facility is not an appropriate category for comparison with the Solvay coal-fired furnaces.

The second facility with an SNCR determination is for an Iowa flat glass melting furnace and curtain coating system at a glass factory. According to the permit, the facility is gas-fired. Furnace operating temperatures are between 2,000°F and 3,000°F (from generic glass furnace information) with outlet temperatures about 900°F (from the permit), which is well into the temperature range for an ammonia or urea NO_X reduction reaction. Although the permit specified SNCR, a permit engineer (Karen Kuhn, 515-281-4306) recalls that the facility ultimately reached its specified emission limit with FGR and low-NO_x burners. Guardian, the facility operator was not contacted for further clarification because with gas-firing, and a furnace exhaust temperature in the appropriate NO_x reaction range, the facility is not comparable to the Solvay furnace. There is no evidence from this updated RBLC review that Solvay should alter its opinion that SCR and SNCR are "infeasible" for its application.

Thus, Solvay believes that the updated RBLC control determinations have not added any control technologies not already being considered.

Coal-Fired - Sources: Kilns, Calciners, Dryers, Furnaces

03/13/03 NOx RBLC DETERMINATIONS

RBLCID	FACILITY	PROCESS	FUEL	THROUGHPUT		POL	CTRL CODE	CONTROL DESCRIPTION	EMISSIONS		BASIS	% EFF
AR-0028	ARKANSAS LIME COMPANY	KILN, LIME	COAL/COKE	625	T/D LIME	NOX	P	PROPER DESIGN AND OPERATION OF LIME KILN	91.2	LB/H	BACT-PSD	
CA-0638	NATIONAL CEMENT COMPANY (KILN MODERNIZATION)	KILN WITH PRE-CALCINER FOR CEMENT MANUFACTURING	COAL/COKE	340	MMBTU/HR	NOX	P	PRE-CALCINER ADDITION TO MODIFIED (SHORTENED) KILNLOWERS TEMPERATURE AND RESIDENCE TIME INSIDE KILN THEREBY REDUCING NOX FORMATION	3.4	LB/TON CLINKER	RACT	0
CO-0043	RIO GRANDE PORTLAND CEMENT CORP.	PREHEATER/PRECALCINER, KILN	PRIMARILY COAL, NATURAL GAS USED OCCASIONALLY.	950000	T/YR	NOX	P	MULTI-STAGE COMBUSTION AND RECIRCULATION. EMISSION LIMIT IN LB/T OF CLINKER. LB/T LIMIT IS 12-MO ROLLING AVG.	2.32	LB/T	BACT-PSD	85
CO-0047	HOLNAM, FLORENCE	KILN/PREHEATER/BYPASS & CLINKER COOLER EXHAUST	COAL			NOX	P	LOW NOX COMBUSTION SYSTEM	2922.71	T/YR	NSPS	
CO-0048	HOLNAM, LAPORTE CO.	CALCINER/ KILN	COAL	584000	T/YR	NOX	P	SPECIAL PROCESS: DESIGN OF BURNER/KILN TO CONTROL ALKALI FROM LIMESTONE INCREASES NOX EMISSIONS.	900	LB/H	BACT-PSD	
FL-0224	FLORIDA ROCK INDUSTRIES, INC.	KILN, PORTLAND CEMENT	COAL	2300	T/D	NOX	P	PROCESS CONTROL AND SECONDARY COMBUSTION OF FUEL. LIMIT IS 30 DAY ROLLING AVERAGE. LIMIT IS LB/TON CLINKER.	2.8	LB/T	BACT-PSD	
IA-0052	LAFARGE CORPORATION	CEMENT MANUFACTURING, PREHEATER/PRECALCINER KILN	COAL	3488	T/D	NOX	P	GOOD COMBUSTION PRACTICES	2546	T/YR	BACT-PSD	
MD-0027	LEHIGH PORTLAND CEMENT COMPANY	CEMENT MANUFACTURING, PREHEATER/PRECALCINER KILN	COAL	2214000	T/YR	NOX	N	A 5-STAGE PREHEATER/PRECALCINER PYROPROCESSING PLANT IS SELECTED FOR NOX EMISSION ABATEMENT. ANY ADD-ON NOX EMISSIONS CONTROL HAS BEEN DETERMINED TO BE EITHER TECHNICALLY OR ENVL INFEASIBLE	4871	T/YR	BACT-OTHER	
MI-0287	HOLNAM, INC.	CEMENT KILNS, WET PROCESS (2)	COAL	100	T/H FEED	NOX	N	CURRENT EXISTING LIMIT DOES NOT REFLECT POTENTIAL 30% REMOVAL IN SLURRY-SCRUBBER. SOME GENERATION OF NO2 BY NATURAL GAS COMBUSTION IN RTOS.	6	LB/T	BACT-OTHER	30
MI-0354	HOLNAM, INC	CEMENT KILNS, WET PROCESS, (2)	COAL	100	T/H	NOX	N		3377	T/YR	BACT-OTHER	
PA-0131	J.E. BAKER COMPANY	KILN #1, COAL/COKE DIRECT-FIRED FULLER ROTARY	COAL/COKE	336	TPD PRODUCT	NOX	N	ANNUAL TESTING REQUIRED	34	LB/TON PRODUCT	RACT	0
PA-0131	J.E. BAKER COMPANY	KILN #2, COAL/COKE DIRECT-FIRED KFS ROTARY	COAL/COKE	540	TPD PRODUCT	NOX	N	ANNUAL TESTING REQUIRED	38	LB NOX/TON PRODUCT	RACT	0
PA-0151	CONSOLIDATED PENNSYLVANIA COAL CO., BAILY MINES	THERMAL COAL DRYER NO. 1	COAL	27	MMTPY	NOX	N		0.8	LB/MMBTU	LAER	0
PA-0151	CONSOLIDATED PENNSYLVANIA COAL CO., BAILY MINES	THERMAL COAL DRYER NO. 2	COAL	27	MMTPY	NOX	A	LNB WITH SOFA, FGR	0.59	LB/MMBTU	LAER	0
TN-0097	TENN LUTTRELL COMPANY	VERTICAL SHAFT LIME KILN	COAL, COKE	370	T/D	NOX	P	INHERENT DESIGN OF THE VERTICAL SHAFT KILN	31.14	LB/H	BACT-PSD	
UT-0059	ASH GROVE CEMENT COMPANY	KILN	COAL	170	T/H	NOX	P	LOW NOX BURNER. PRIMARY EMISSION LIMIT: 400 LB/H AT 90% OF MAX PRODUCTION CAPACITY. NOTE: TITLE V PERMIT DOES NOT INCLUDE AT 90% OF MAXIMUM PRODUCTION""	400	LB/H	BACT-PSD	
UT-0062	HOLNAM, DEVIL'S SLIDE PLANT	KILN	COAL			NOX	P	LOW NOX BURNER	251	LB/H	NSPS	
VA-0210	W. S. FREY COMPANY, INC.	KILN, LIME	COAL	182500	T/YR	NOX	N		58.3	LB/H	NSPS	99
WI-0090	WESTERN LIME CORPORATION	LIME KILN #2, P38, S18	COAL	123.3	MMBTU/H	NOX	P	BACT FOR NITROGEN OXIDES HAS BEEN DETERMINED TO BE GOOD COMBUSTION PRACTICES WITH AN EMISSION LIMIT OF 60.0 POUNDS PER HOUR, AS MEASURED BY USEPA METHOD 7	60	LB/H	BACT-PSD	
WY-0044	MOUNTAIN CEMENT COMPANY-LARAMIE FACILITY	KILN, COAL FIRED	COAL	45.3	T/H COAL		P	COMBUSTION UNIT DESIGN (WELL DESIGNED PROCESS BURNER OPERATED IN DESIGN RANGE)	208.8	LB/H (30DAY ROLLING)	BACT-PSD	20

Unspecified Fuel - Sources: Kilns, Calciners, Dryers, Furnaces

03/13/03 NOx RBLC DETERMINATIONS

RBLCID	FACILITY	PROCESS	FUEL	THROUGHPUT	CTRL CODE	CONTROL DESCRIPTION	EMISSIONS	BASIS	% EFF
AL-0077	TUSCALOOSA STEEL CORP.	FURNACE, DIRECT REDUCED IRON (DRI) SHAFT		68 T/H	N		38.8 LB/H	BACT-PSD	0
AL-0077	TUSCALOOSA STEEL CORP.	FURNACE, ELECTRIC ARC (EAF)		160 T/H	N		0.35 LB/T	BACT-PSD	0
AL-0077	TUSCALOOSA STEEL CORP.	FURNACE, EQUALIZING		160 T/H	P	LOW NOX BURNERS	36 LB/H	BACT-PSD	0
AL-0080	LOUISIANA PACIFIC CORP.	WOOD WAFER DRYERS, ROTARY DRUM (5)		0	P	LOW NOX BURNERS	67.74 LB/H	BACT-PSD	0
AL-0086	TUSCALOOSA STEEL CORP. - MOBILE DRI PLANT	REFORMER AND DIRECT REDUCED IRON SHAFT FURNACE		150 T/H	P	LOW NOX BURNERS	105 LB/H	BACT-PSD	0
AL-0087	TRICO STEEL CO., LLC	FURNACE, ELECTRIC ARC - CARBON STEEL		440 T/H	A	DIRECT EVACUATION CANOPY (DEC)	0.35 LB/T	BACT-PSD	0
AL-0087	TRICO STEEL CO., LLC	METALLURGICAL FURNACES, LADLE		440 T/H	N		0.02 LB/T	BACT-PSD	0
AL-0097	MEAD COATED BOARD, INC.	FURNACE RECOVERY		2.7 MMLB/D BLS	P	COMBUSTION CONTROL	112 PPMDV @ 8% O2	BACT-PSD	0
AL-0116	GULF STATES PAPER CORPORATION	FURNACE, RECOVERY		3.94 MMLB/D BLS	P	PROPER DESIGN AND OPERATION	90 PPMDV @ 8% O2	BACT-PSD	0
AL-0116	GULF STATES PAPER CORPORATION	PAPER MACHINE W/ DRYERS		0	B	LOW NOX BURNERS ON NATURAL GAS DRYERS.	0 NO NUMERIC LIMIT	BACT-PSD	0
AL-0124	SIMCALA INC	FURNACE, ELECTRIC ARC SILICON		20 MW	P	GOOD FURNACE OPERATION PRACTICES	5.96 LB/MW-H	BACT-PSD	0
AL-0129	IPSCO STEEL INC	FURNACE, ELECTRIC ARC		200 T/H	N		0.4 LB/T	BACT-PSD	0
AL-0129	IPSCO STEEL INC	FURNACE, REHEAT		200 T/H	P	LOW NOX BURNER	172 LB/MMFT3	BACT-PSD	0
AL-0136	ANNISTON ARMY DEPOT	FURNACE, DEACTIVATION		22.8 MMBTU/H	A	QUENCH TOWER, VENTURI SCRUBBER, DEMISTER	1.263 G/DSCM	BACT-PSD	98.5
AL-0137	ANNISTON ARMY DEPOT	FURNACE, METAL PARTS		10.6 MMBTU/H	A	QUENCH TOWER, VENTURI SCRUBBER	621 MG/DSCM	BACT-PSD	98.5
AR-0021	QUANEX CORPORATION - MACSTEEL DIVISION	ELECTRIC ARC FURNACES, 2		86 T/H	P	EXISTING NATURAL GAS OXY-FUEL BURNERS	43.9 LB/H	BACT-PSD	0
CA-0539	KRAFT GENERAL FOODS, INC.	DRYER, SPRAY, WHEY		15 MMBTU/HR	P	LOW NOX BURNER, FUEL SPEC: USE OF NATURAL GAS	0.04 LB/MMBTU	BACT-OTHER	70
CA-0563	RESOURCE RENEWAL TECHNOLOGIES, INC.	DRYER/MIXER		2600 TPD	P	LOW NOX BURNER, FUEL SPEC: SWITCHING FROM DIESEL TO LPG OR NG	0.081 LBM/MMBTU	BACT-OTHER	70
CA-0594	FERTECH ENVIRO SYSTEMS, INC.	SOIL REMEDIATION DRYER/KILN/AFTERBURNER		0	A	KILN BURNER/AFTERBURNER (SEE NOTES)	0.12 LBM/MMBTU	BACT-OTHER	0
CA-0598	CALIFORNIA SYNFUELS RESEARCH CORP	PSA HYDROGEN REFORMER FURNACE		0	B	LOW NOX BURNERS AND PSA HYDROGEN PURGE	249 LBM/DAY	BACT-OTHER	90
FL-0071	FLORIDA MINING & MATERIALS	KILN #2, CEMENT		79.59 T/H	P	GOOD COMBUSTION	250 LB/H 30 DAY AVE	BACT-PSD	0
FL-0087	CHAMPION INTERNATIONAL CORP	LIME KILN		0	P	GOOD COMBUSTION	200 PPM	BACT-PSD	0
FL-0221	FLORIDA STEEL CORPORATION	ELECTRIC ARC FURNACE		600000 T/YR	N	LIMIT MEASURED AS 0.33 LB NOX AS NO PER TON STEEL PRODUCED.	0.33 LB/T	BACT-PSD	
GA-0060	OWENS-CORNING	WOOL FIBER GLASS FURNACE, ELECTRIC		0	P	LIMIT SODIUM NITRATE USAGE: LB(NOX) = LB(NANO3) * 0.541	13.5 LB/ T GLASS PULLED	RACT	0
GA-0061	OWENS-BROCKWAY GLASS CONTAINERS, INC.	CONTAINER GLASS FURNACE		229 T/D	P	FURNACE DESIGN AND LOW NOX BURNERS	5.5 LB/T GLASS PRODUCED	RACT	67
GA-0064	RIVERWOOD INTERNATIONAL CORPORATION	KILNS, 1 AND 2		8.4 T/H CAO PER KILN	P	LOW NOX BURNERS	3.5 LB/T CAO	BACT-PSD	0
IA-0027	GUARDIAN INDUSTRIES	FLAT GLASS FURNACE		0	B	MINIMIZE FURNACE TEMP/MINIMIZE EXCESS AIR/REDUCED NOX BURNERS/SNCR	325 LB/HR	BACT-PSD	35
IA-0029	CARGILL, INC.	CARBON REACTIVATION FURNACE		22 TONS/DAY	P	LOW NOX BURNERS	1.4 LB/HR	BACT-PSD	85
IA-0029	CARGILL, INC.	FIBER DRYER SYSTEM		65 MMBTU/HR	B	LOW NOX BURNER, CUSTOM FABRICATED THERMAL OXIDIZER	9.1 LB/HR	BACT-PSD	85
IA-0029	CARGILL, INC.	SWEETENER DRYER/COOLER		134400 LB/DAY	P	LOW NOX BURNERS	7 LB/HR	BACT-PSD	85
IA-0055	IPSCO STEEL, INC	ELECTRIC ARC FURNACE MELTSHOP EP # 1			N		7.66 PPM	BACT-PSD	
IA-0057	CARGILL, INC	BARR-ROSIN FIBER FLASH DRYER SYSTEM		80 MMBTU/H	N		11.2 LB/H	BACT-PSD	
IL-0050	PPG INDUSTRIES	FURNACE, FLAT GLASS		750 T/D GLASS	P	FURNACE DESIGN OPTIMIZATION	12.25 LB/T OF GLASS	BACT-PSD	50
IL-0051	BIRMINGHAM STEEL	FURNACE, ELECTRIC ARC, STEEL PRODUCTION		100 T/H	P	LOW-NOX SUPPLEMENTAL BURNERS, 0.14 LB/MMBTU	0.26 LB/T OF STEEL	BACT-PSD	0
IL-0052	MISSISSIPPI LIME COMPANY	KILN, ROTARY, LIME		2600 T/D	P	LIME CALCINATION PROCESS	0.56 LB/T OF STEEL	BACT-PSD	0
IL-0057	ILLINOIS CEMENT COMPANY	KILN, CEMENT, PREHEATER-PRECALCINER		3000 TON/D CEMENT CLINKER	P	CONVERSION TO PRECALCINER KILN	4.5 LB/T CLINKER	BACT-PSD	0
IL-0063	PQ CORPORATION	FURNACE, SODIUM SILICATE, TWO		0	P	LOW-NOX COMBUSTION TECHNOLOGIES.	6 LB/T	BACT-PSD	0
IN-0054	NUCOR STEEL	FURNACE, ELECTRIC ARC (2)		0	N	NONE FEASIBLE	0.5 LB/T STEEL	BACT-PSD	0
IN-0054	NUCOR STEEL	FURNACE, ROLLER HEARTH		0	P	LOW NOX BURNERS, ADDING SECOND ROLLER HEARTH FURNACE	20 LB/MMCF	BACT-PSD	0
IN-0061	STEEL DYNAMICS, INC.	ELECTRIC ARC FURNACE #1		225 T/H	P	LOW NOX BURNERS	0.51 LB/T	BACT-PSD	0
IN-0062	STEEL DYNAMICS, INC.	LADLE DRYOUT FURNACE		5 MMBTU/H	P	LOW NOX BURNERS	0.1 LB/MMBTU	BACT-PSD	0
IN-0062	STEEL DYNAMICS, INC.	TUNDISH DRYER		1.5 MMBTU/H	P	LOW NOX BURNERS	0.1 LB/MMBTU	BACT-PSD	0
IN-0073	QUALITECH STEEL CORP.	ELECTRIC ARC FURNACE (EAF)		135 T/H	N		0.5 LB/T	BACT-PSD	0
IN-0073	QUALITECH STEEL CORP.	LADLE PREHEAT/DRYER STATIONS		8 MMBTU/H	P	LOW NOX BURNERS	0.1 LB/MMBTU	BACT-PSD	0
IN-0073	QUALITECH STEEL CORP.	REHEAT FURNACE		175 MMBTU/H	P	LOW NOX BURNERS	0.15 LB/MMBTU	BACT-PSD	0
IN-0073	QUALITECH STEEL CORP.	TUNDISH DRYER		5 MMBTU/H	P	LOW NOX BURNERS	0.1 LB/MMBTU	BACT-PSD	0
IN-0077	STEEL DYNAMICS, INC.	FURNACE, SUBMERGED ARC		106 T/H	N		0.117 LB/T	OTHER	0
KY-0062	NEW RIVER LIME, INC.	KILN, ROTARY LIME (4)		46 T/H	P	LOW NOX BURNERS	96 LB/H	BACT-PSD	0
KY-0064	DRAVO LIME COMPANY - KY ROUTE 10	KILN, ROTARY LIME (2)		46 T/H	P	REDUCE NOX FROM COMBUSTION WITH NEW ROTARY KILN AND CALCINER - PREHEATER KILNS (PROCESS EQUIPMENT)	90.292 LB/H	BACT-PSD	0
LA-0088	CABOT CORPORATION	DRYER, UNIT 4 PELLET		23.4 MMBTU/H	P	DESIGN AND PROPER OPERATION	12.4 LB/H	BACT-PSD	0

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RBLCID	FACILITY	PROCESS	FUEL	THROUGHPUT	CTRL CODE	CONTROL DESCRIPTION	EMISSIONS	BASIS	% EFF
LA-0122	INTERNATIONAL PAPER - MANSFIELD MILL	LIME KILN		142 MMBTU/H	P	GOOD PROCESS CONTROLS, WATER CONTENT OF LIME	103.7 LB/H	BACT-PSD	
LA-0122	INTERNATIONAL PAPER - MANSFIELD MILL	LIME KILN AUXILIARY ENGINE		370 HP	P	PREVENTATIVE MAINTENANCE	4.2 LB/H	BACT-PSD	
LA-0123	EXXONMOBIL BATON ROUGE REFINERY	FRACTIONATOR FURNACE		360 MMBTU/H	A	ULTRA LOW-NOX BURNERS	14.4 LB/H	BACT-PSD	
LA-0123	EXXONMOBIL BATON ROUGE REFINERY	HYDROFINER FURNACE 1		150 MMBTU/H	A	ULTRA LOW-NOX BURNERS.	6 LB/H	BACT-PSD	
LA-0123	EXXONMOBIL BATON ROUGE REFINERY	HYDROFINER FURNACE 2		197 MMBTU/H	A	ULTRA LOW-NOX BURNERS.	7.88 LB/H	BACT-PSD	
MN-0026	MINNESOTA CORN PROCESSORS	CORN GLUTEN DRYER		0	P	FLUE GAS RECIRCULATION (FGR) AND COMBUSTION CONTROL	3.07 LB/H	BACT-PSD	0
MN-0027	POTLATCH CORPORATION - WOOD PRODUCTS, MN DIV.	WOOD-FIRED ROTARY WOOD FLAKE DRYERS		30 T/H FLAKES	P	GOOD COMBUSTION PRACTICES, INCLUDING PROPER MAINTENANCE AND LIMITING EXCESS AIR.	45.8 LB/H	BACT-PSD	0
MO-0048	LAFARGE CORPORATION	RAW MILL, PREHEATER/PRECALCINER KINL(EP 78)		1584071 TONS	P	GOOD COMBUSTION PRACTICES	1894.8 TON/YR	BACT-PSD	0
MS-0029	WEYERHAEUSER COMPANY	KRAFT PULP MILL, LIME KILN		504 T/D CAO	P	EFFECTIVE OPERATION OF THE KILN	300 PPMVD @3.6% O2	BACT-PSD	0
MS-0029	WEYERHAEUSER COMPANY	RECOVERY FURNACE AND BOILER		7 MMLBS/DAY	P	STAGED COMBUSTION	80 PPMVD @ 8% O2	BACT-PSD	0
MT-0006	CONTINENTAL LIME-INDIAN CREEK OP'N	LIME KILNS		500 TPD CAO EACH	N		77.5 LBS/HR	BACT-PSD	0
MT-0012	CONTINENTAL LIME INC.	KILN-LIME, TWO		0	A	BAGHOUSES, 75000 ACFM AT 470F WITH APPROX. 17000 SQ.FT AND AN AIR-TO-CLOTH RATIO OF 4:4:1.	77.5 LB/H EACH	BACT-PSD	0
NC-0062	WEYERHAEUSER COMPANY	MICROBOARD DRYERS		0	A	SCR AS AN INTEGRAL PART OF THE RCO	61.8 LB/H	BACT-PSD	50
NH-0006	GROVETON PAPER BOARD, INC.	CHEMICAL RECOVERY KILN		16.5 GAL/MIN@50+-5%	N	NONE	0.85 LBS/TON BLACK LIQ/SL	RACT	0
NV-0032	GREAT STAR CEMENT CORP./UNITED ROCK PRODUCTS CORP.	CEMENT KILN/CLINKER COOLER FACILITY		0	B	SELECTIVE NON-CATALYTIC REDUCTION (SNCR) UREA INJECTION SYSTEM AT PREHEATER	3.1 LB/TON CLINKER PROD.	BACT-PSD	50
UT-0041	ASHGROVE CEMENT COMPANY	KILN, 1 EACH		150 T/YR	N		336 LB/HR	BACT	0
VA-0196	TEXASGULF, INC.	#3 KILN DEFLUORINATION		21.1 T/H	N		53.6 LB/H	BACT-OTHER	0
VA-0219	GEORGIA-PACIFIC CORPORATION	ENERGY SYSTEM AND DRYERS		318300 TON FLAKES/YR	A	MULTICYCLONE AND ESP	203.72 TPY	NSPS	0
VA-0224	LOUISIANA-PACIFIC CORP.--NORTHERN DIV.	WAFER DRYER AND PRESS		37 TPH & 13.02 TPH	N		24.3 LB/HR	BACT-OTHER	0
VA-0226	ROANOKE ELECTRIC STEEL CORPORATION	LADLE FURNACE		500000 TPY	N		15 TPY	BACT-PSD	0
VA-0226	ROANOKE ELECTRIC STEEL CORPORATION	NO. 5 ELECTRIC ARC FURNACE		500000 TPY	N		30 TPY	BACT-PSD	0
VA-0241	ROANOKE ELECTRIC STEEL CORPORATION	FURNACE, ELECTRIC ARC #5		100 T/H OF STEEL	N		37.8 LB/H	BACT-PSD	0
WI-0075	CHARTER STEEL PLANT	ELECTRIC ARC FURNACE (EAF) SHOP		40.83 T/H	P	OPERATING PRACTICES	0.51 LB/T STEEL TAPPED	BACT-PSD	0
WI-0079	LOUISIANA PACIFIC CORP.	DRYER, WOOD		21.58 MMBTU/H	B	GOOD COMBUSTION, LOW NOX TECHNOLOGY IN RTO	18.38 LB/H	BACT-PSD	0
WI-0082	CLM CORP.	KILN, LIME (4)		36 T/H INPUT	P	COMBUSTION CONTROL	56 LB/H	BACT-OTHER	0
WI-0083	CARDINAL FLAT GLASS	FLAT GLASS MFG, MELTING FURNACE		550 T/D	P	PROPER FURNACE DESIGN	400 LB/H	BACT-PSD	0
WI-0094	CHARTER STEEL DIVISION	ELECTRIC ARC FURNACE, MELT SHOP, P01, S01		450000 T/YR	P	CONTROL OF OPERATING PARAMETERS TO ENSURE PROPER OPERATION OF THE EMISSIONS UNITS	0.51 LB/H	BACT-PSD	
WY-0035	TEXASGULF SODA ASH PLANT	ROTARY DRYER, SODA ASH		122 T/H WET CRYSTAL	P	LOW NOX BURNERS - NORTH AMERICAN BURNER	0.15 LB/MMBTU	BACT-PSD	0
WY-0038	WOLD TRONA CO.	CALCINER & CALCINER BOILER, (2)		213.15 T/H	P	MONOWALL FURNACE CONSTRUCTION LOW NOX BURNERS WITH FUEL STAGING, 15% EXCESS AIR FLUE GAS RECIRCULATION(FGRS 15%) ON CALCINER BOILER	0.048 LB/MMBTU	BACT-PSD	0

NO$_X$ Control Procedures Calciner CA-1 and CA-2 Coal-Stoker Furnaces

Rev. 4/30/03

Solvay Minerals, Inc.

Based on Detroit Stoker Company CFD Modeling, Job No. ES-111

1. NO$_X$ Reduction Technologies

1.1 Basic System, with Optimized Overfire Air (OFA) Configuration

a. General Description. The original conventional overfire and tempering air furnace design was optimized with reduced lower furnace section stoichiometry, allowing complete combustion higher up in the furnace. This system emulates a conventional boiler overfire air system and provides better mixing.

b. Equipment. Higher pressure overfire air headers and nozzles, including automatic control dampers and overfire air fan, were optimized with Computation Fluid Dynamic (CFD) modeling. There are three rows of overfire air nozzles in the front (stoker side) of the furnace and three rows in the rear. Nozzle locations are shown in the figure entitled "NO$_X$ Concentration Original OFA versus Optimized OFA".

c. Process. Air requirement is 45,000 ACFM at 80°F and 20 inches WC, for each furnace. NO$_X$ emission according to the CFD model is 0.79 lb/MM Btu. The CFD model figure entitled "NO$_X$ Concentration Original OFA versus Optimized OFA" shows the effect on NO$_X$ concentrations in various areas of the furnace.

d. Control. Overfire air will be controlled proportional to fuel flow with optimization to control other furnace factors including temperature, slag and NO$_X$ emission rate. Solvay's existing distributed control system computers (DCS) will be used.

1.2 Flue Gas Recirculation (FGR)

e. General Description. Calciner flue gas, after the electostatic precipitor but before the calciner ID fan, will be diverted and injected into several locations to reduce NO_X by reducing the furnace temperature and displacing oxygen.

f. Equipment. A fan will be used to return the flue gas to the furnace. The majority of the flue gas will be ducted to the undergrate chamber. A small percentage will be ducted to the coal feeder distributor area and the remainder will be ducted to the lower rear overfire air nozzles. Each of the FGR headers will have automatic flow control dampers.

g. Process. The quantity of FGR, which will be at the temperature of the calciner offgas of 400°F, will be 30% in terms of flue gas produced by the furnace. Furnace outlet temperature will be reduced. NO_X emissions according to the CFD model and Detroit Stoker's estimate will be reduced 34% to 0.52 lb/MM Btu. The CFD model figure entitled "NO_X Concentration Uncontrolled versus with Flue Gas Recirculation" shows the reduction of NO_X concentrations in various areas of the furnace.

h. Control. FGR flow will be controlled proportionally with the coal and trona ore feed rates using the DCS system. Furnace temperature, slag conditions, and NO_X emission will be factored into the control program.

1.3 Water Injection (WI)

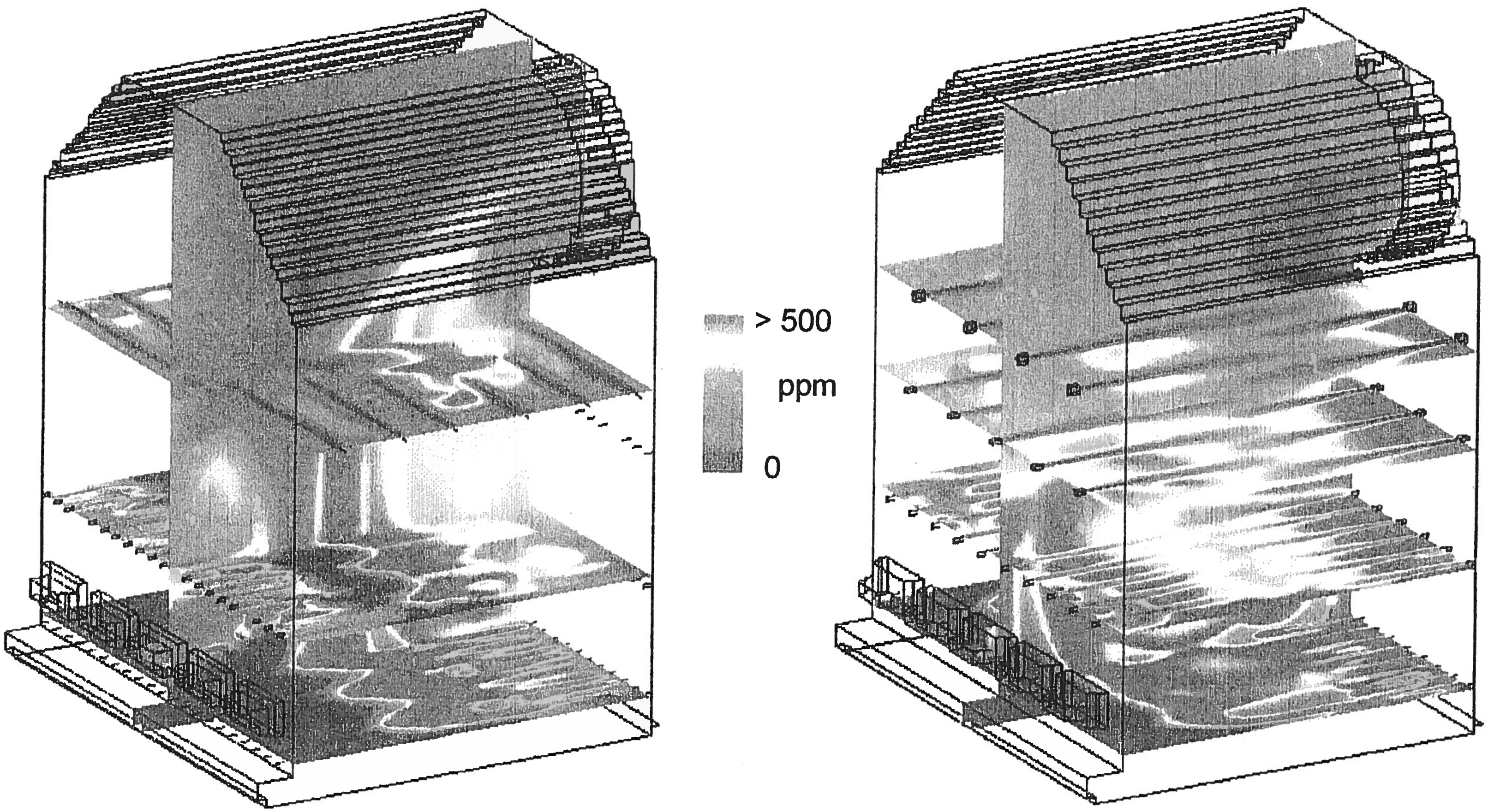
i. General Description. OFA and FGR are supplemented with water injection to reduce NO_X by lowering the flame temperature and displacing oxygen.

j. Equipment. The front and rear walls of the furnace will each have a common header with one control solenoid valve per four spray nozzles. Water injection spray nozzles were modeled to be located below the OFA nozzles as shown in the figure entitled "NO_X Concentration Uncontrolled versus with Water Injection".

k. Process. Water flow requirement is 10 GPM in the rear and 5 GPM in the front. Furnace outlet temperature will be reduced. NO_X emissions according to the CFD model and Detroit Stoker's estimate will be further reduced 13.5% to 0.45 lb/MM Btu. The CFD model figure entitled "NO_X Concentration Uncontrolled versus with Water Injection" shows the reduction of NO_X concentrations in various areas of the furnace.

1. <u>Control.</u> Water flow will be controlled by the DCS system, proportional to coal feed rate, furnace temperature, slag conditions, and NO_X emission.

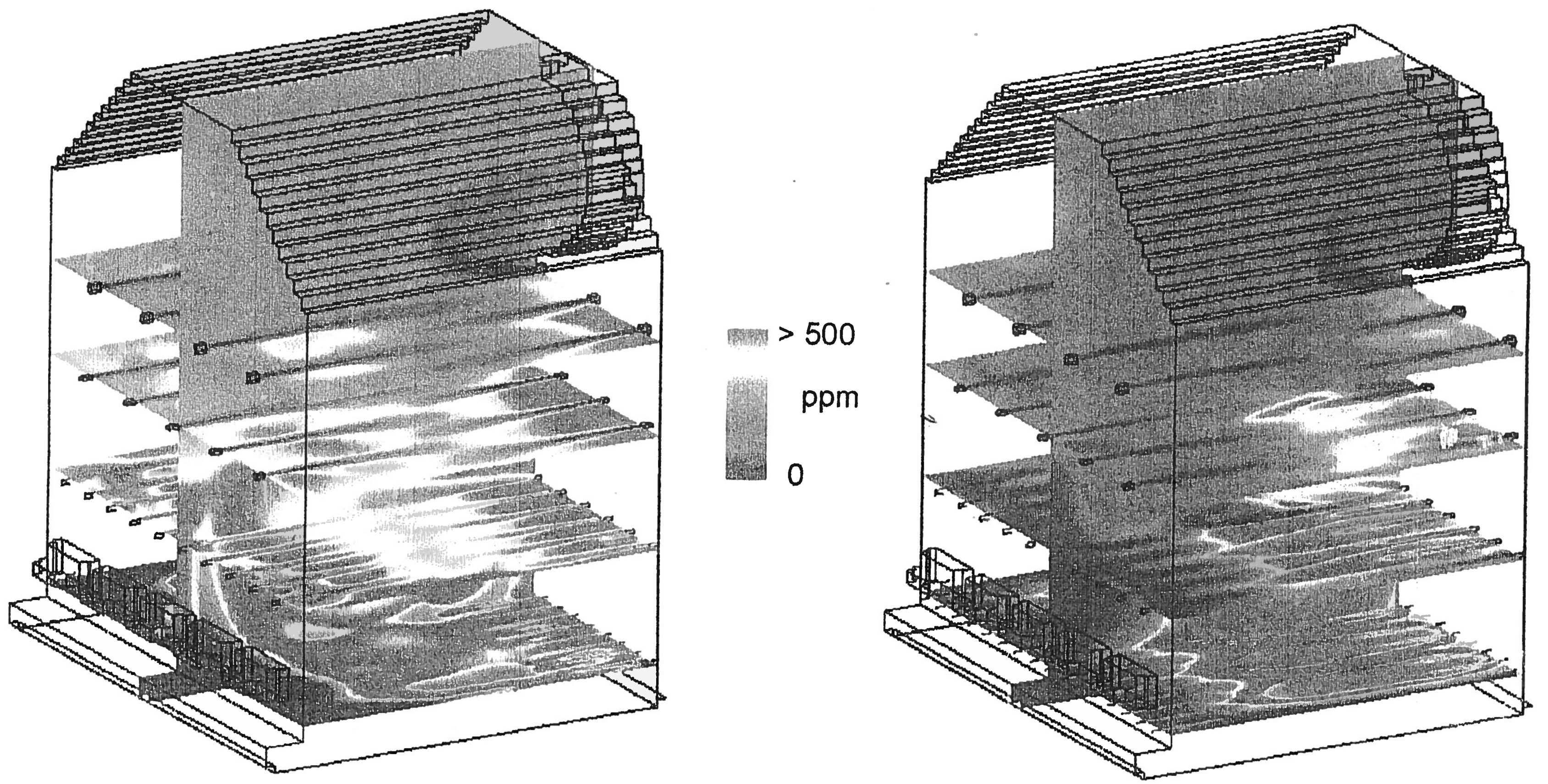
NOx Concentration Original OFA versus Optimized OFA



Original OFA Configuration

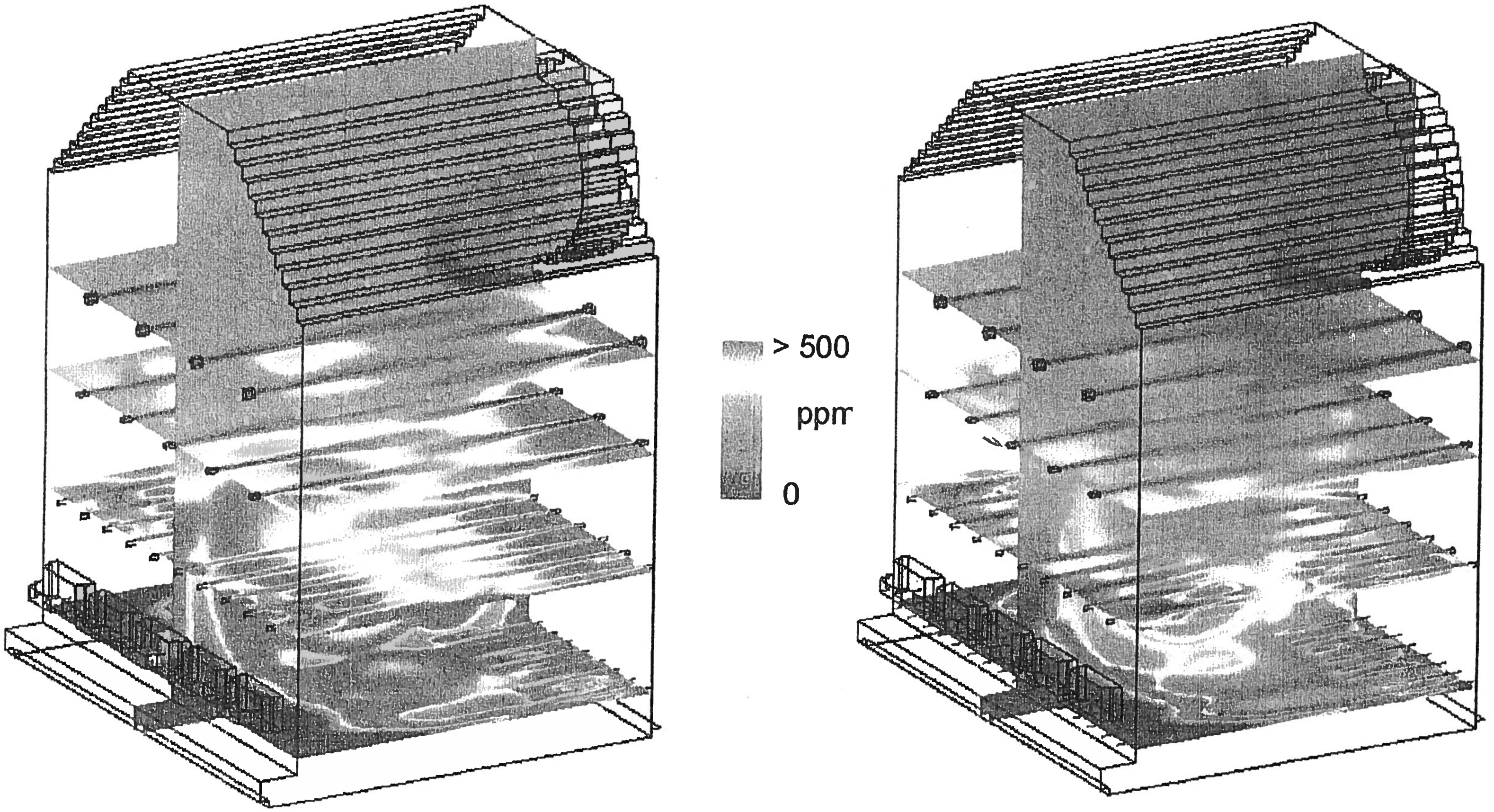
Optimized OFA

NOx Concentration Uncontrolled versus with Flue Gas Recirculation



Uncontrolled **FGR**

NOx Concentration Uncontrolled versus with Water Injection



Uncontrolled

Water Injection

AP-0631

Solvay Minerals